



Entity-Based Modeling: *The Department Head Tour Length Problem for SWOs*

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Much of this work was preformed under contract to
NPRST, working with Kimberly Crayton and Ilia
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SWO Career Path Model

“Develop a model to solve a particular problem, not to model the system.”

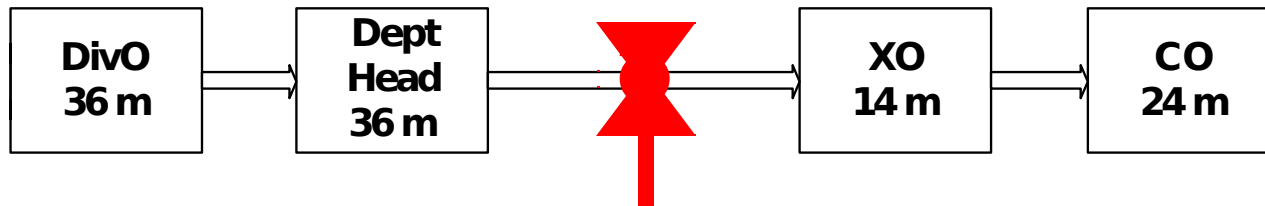
John Sterman

- Our goals had wider model boundaries than for a single, specific question
- Ideally, generic tool for many questions



SWO DH Tour Lengths

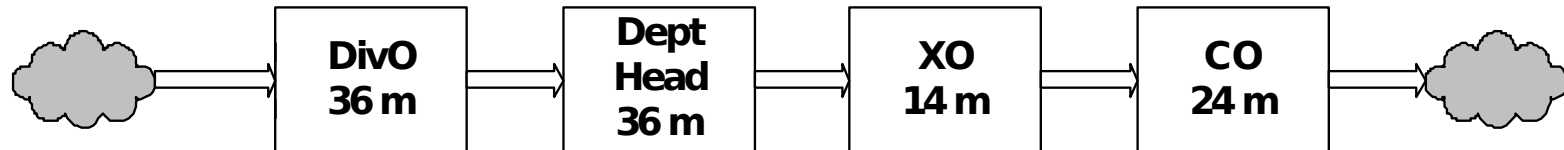
- DH tour lengths are adjusted based on inventory to maintain selectivity



- Cannot reasonably solve the problem in a single step
- DHs may have different tour lengths based on when they arrived



Approach: Stock and Flow

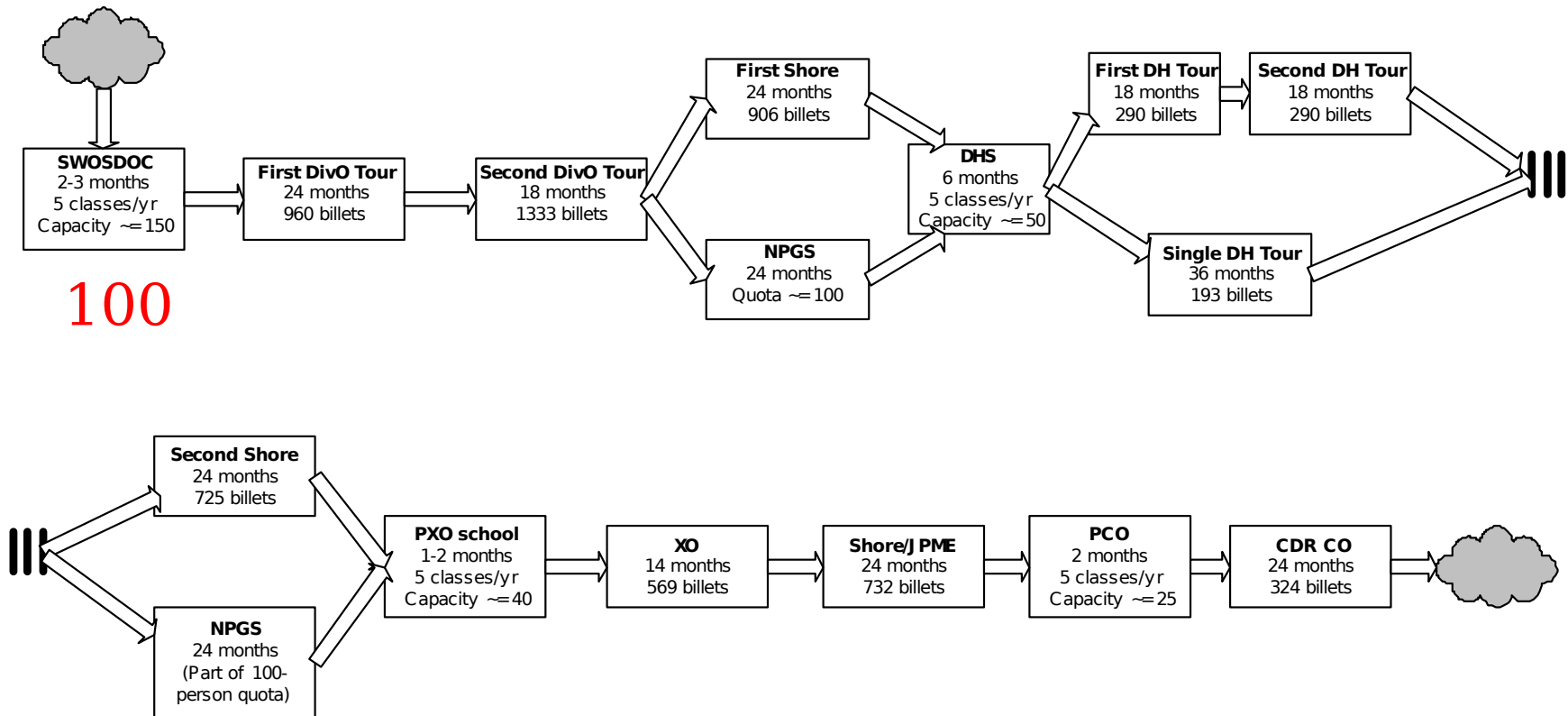


- **Stocks** have a number that represents how many “things” are in them
- **Flows** govern how many “things” transition between the stocks
- System Dynamics, Continuous Simulation
- Discrete event



Typical Stock-and-Flow

Numbers flow through stocks



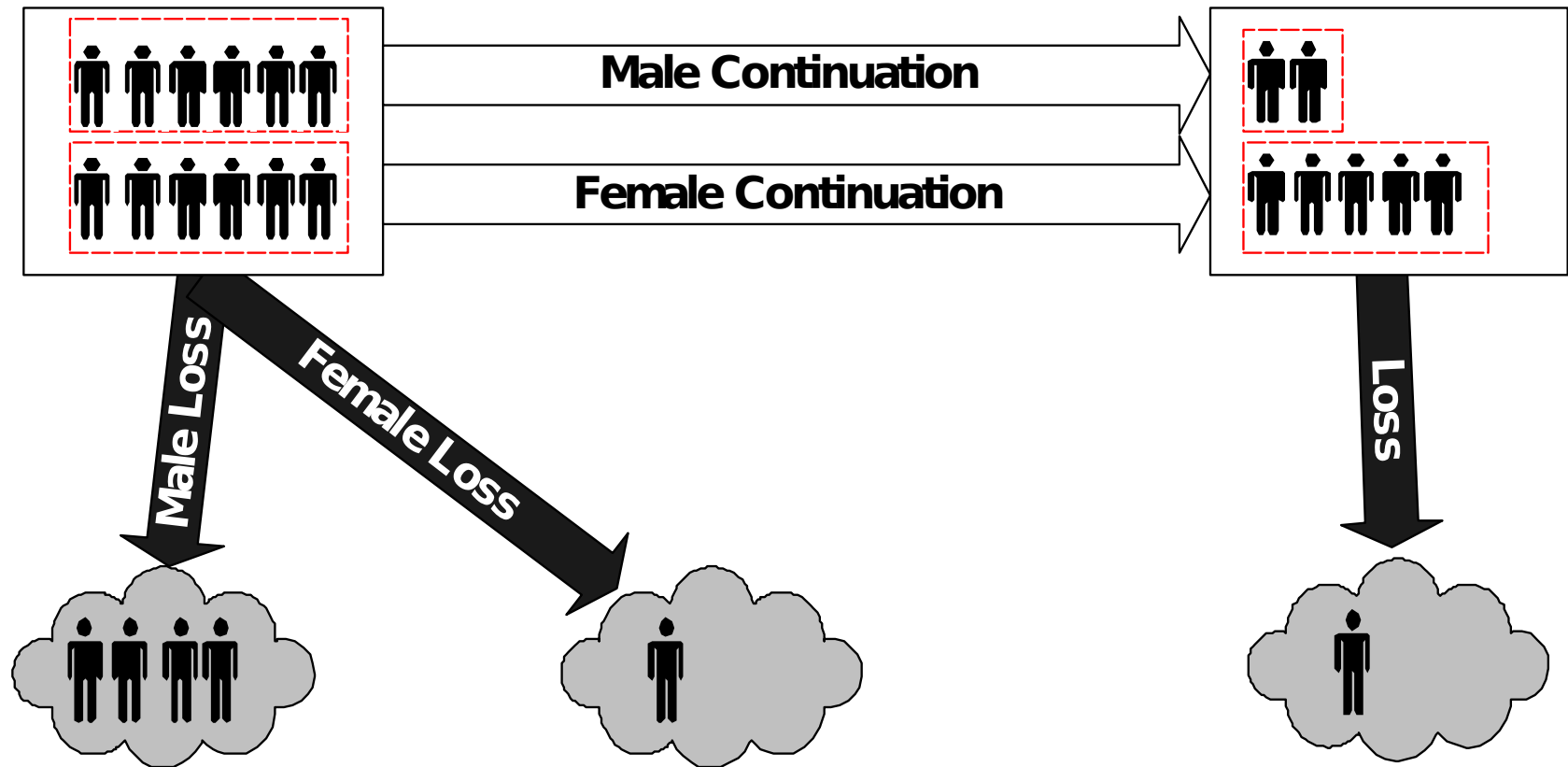


Attribute Explosion

Attributes	Combinations
Typical Stock	1
Gender	2
Gender + Screened	4
Rank	6
Gender + Screened + Rank	24
Year group	22
Gender + Screened + Rank + YG	528

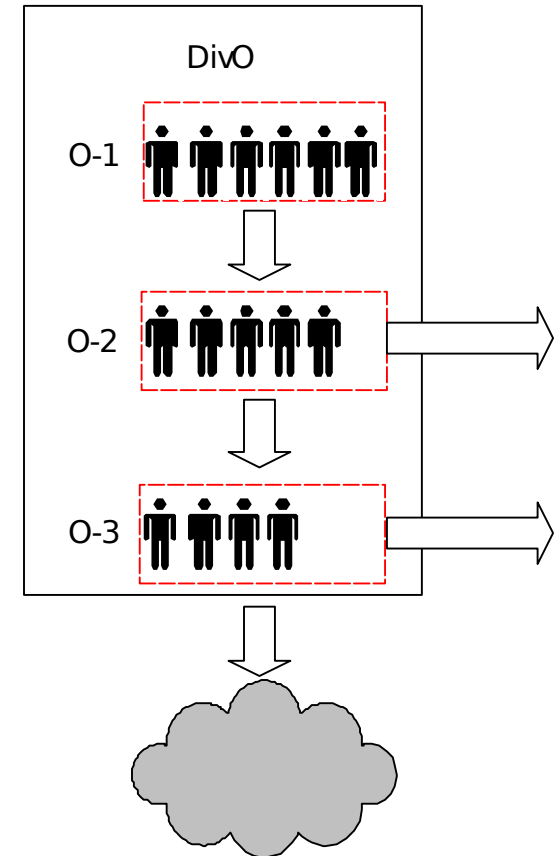
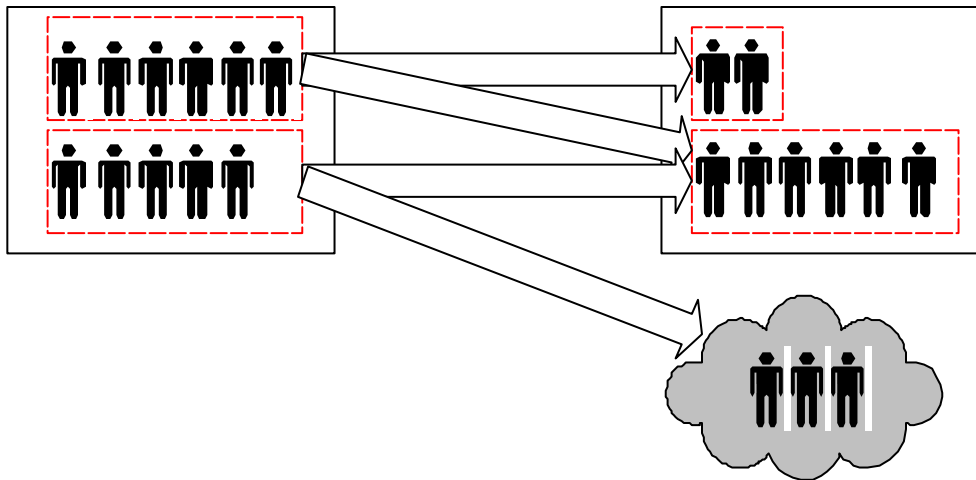


Discrete Event with Attributes



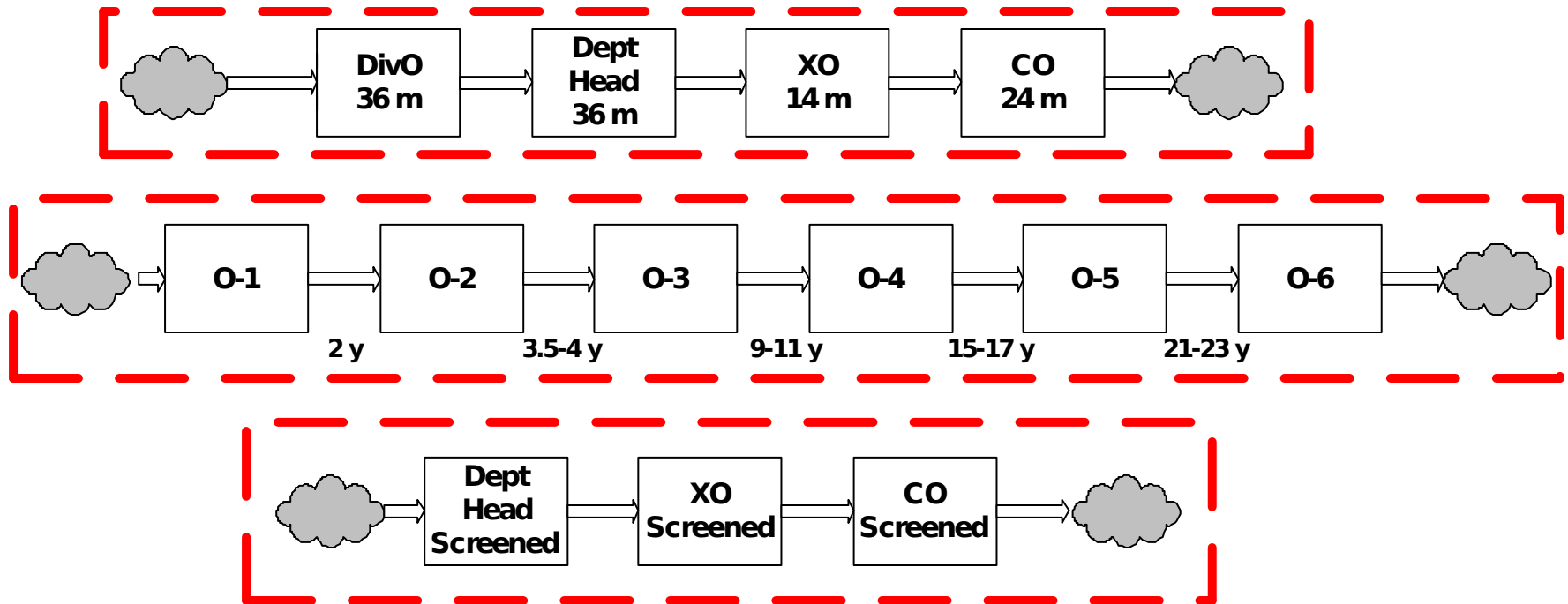


Attributes Change on Flows





Multiple Paths Simultaneously



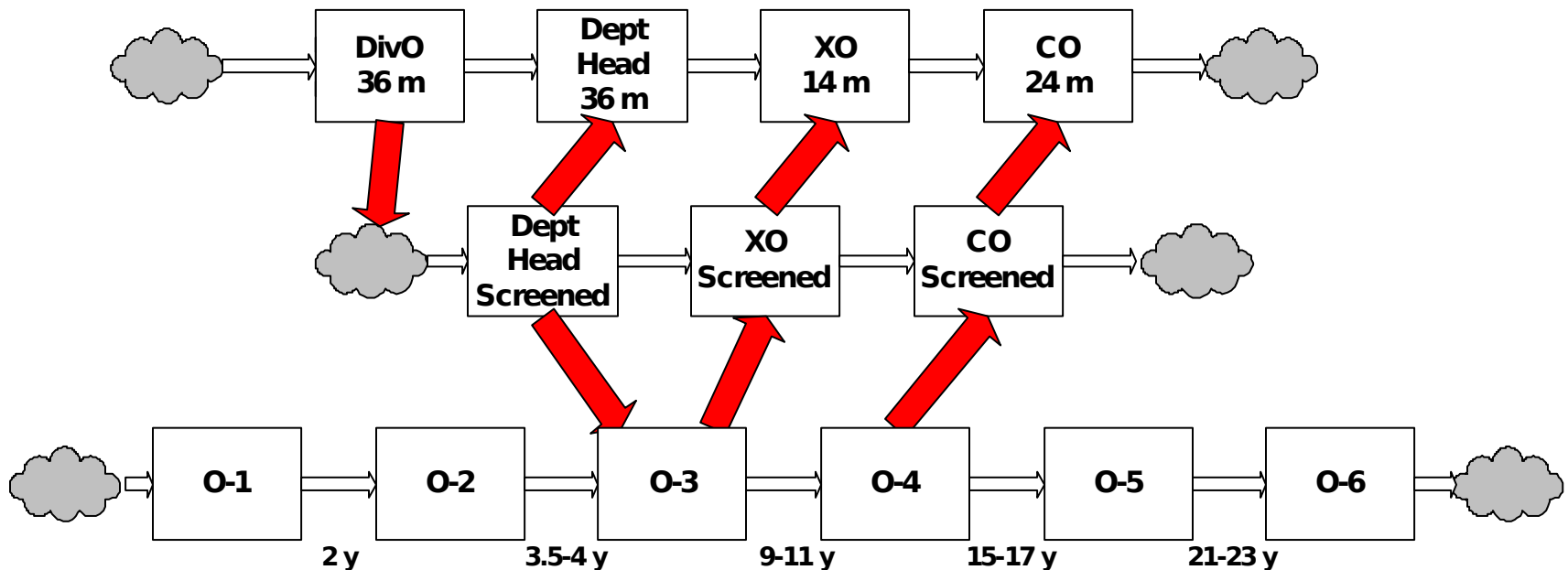
“...it is difficult for time-dependent operations to be intertwined with the tour flows.”

David Rodney
CRM 92-81



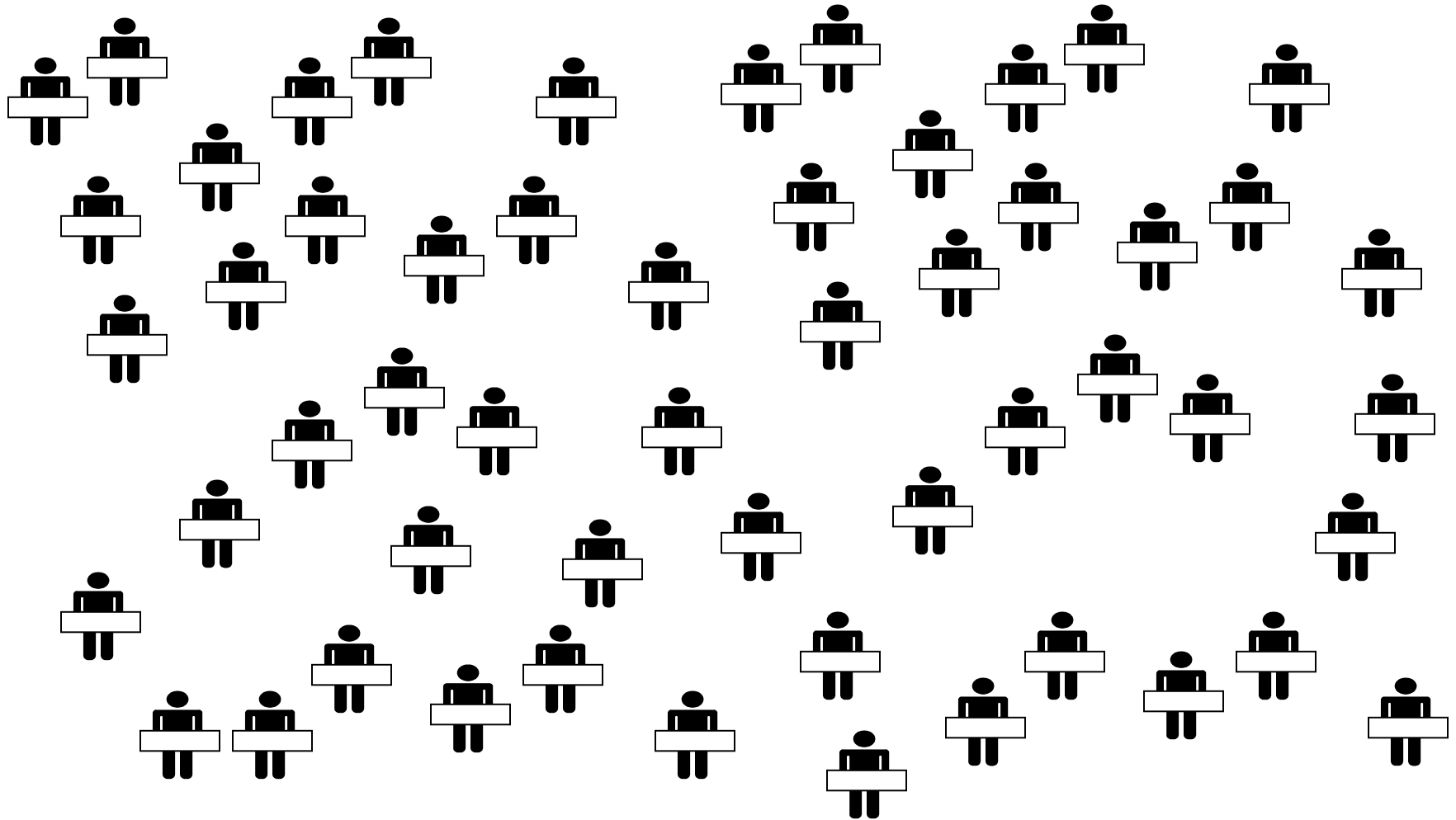
Paths are Dependent

In fact, the real-world business rules are not simply time dependent; there are interdependencies between the models.





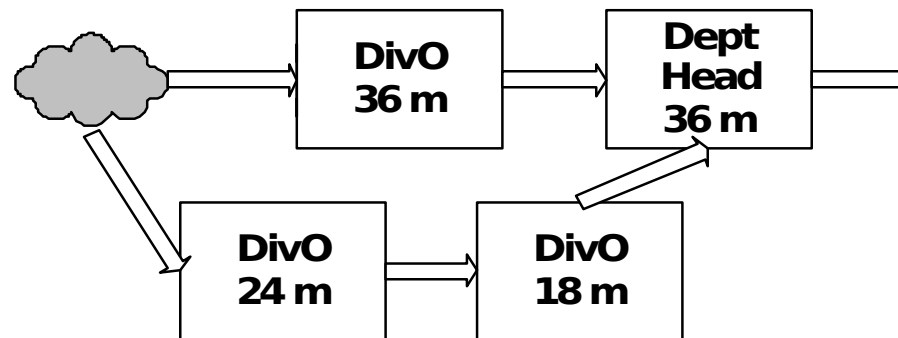
Solution (Pt 1): Entity-Based





State/Behavior in Stock-and-Flow

- State and behavior are tightly coupled
- Cumbersome:
 - People cannot be in two places at once
 - State can be lost once paths merge





State/Behavior in Entity-

- State: **Entities** and their **Attributes**
 - Entities are individual people
 - Attributes are generic attribute/value pairs
- Behaviors: **Business Rules**

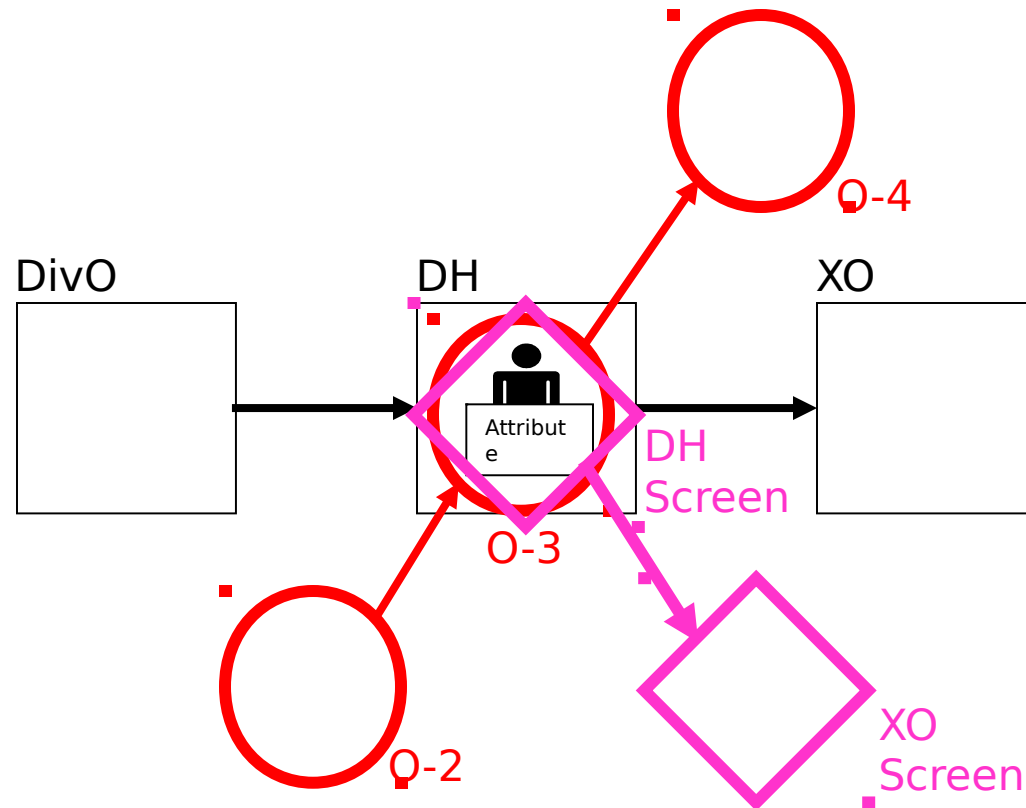
Generic rules, based on core processes

 - Distribution (Moving people)
 - Selection (Changing people)



Solution (Pt 2): Process Flow

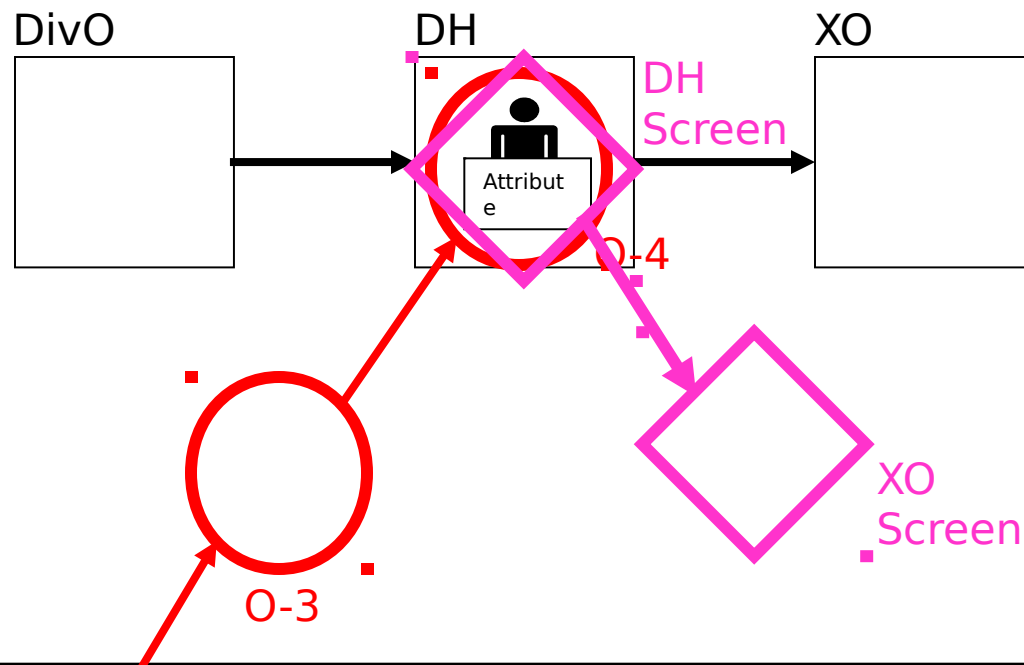
Entities don't flow, processes flow around them





Process Flow 2

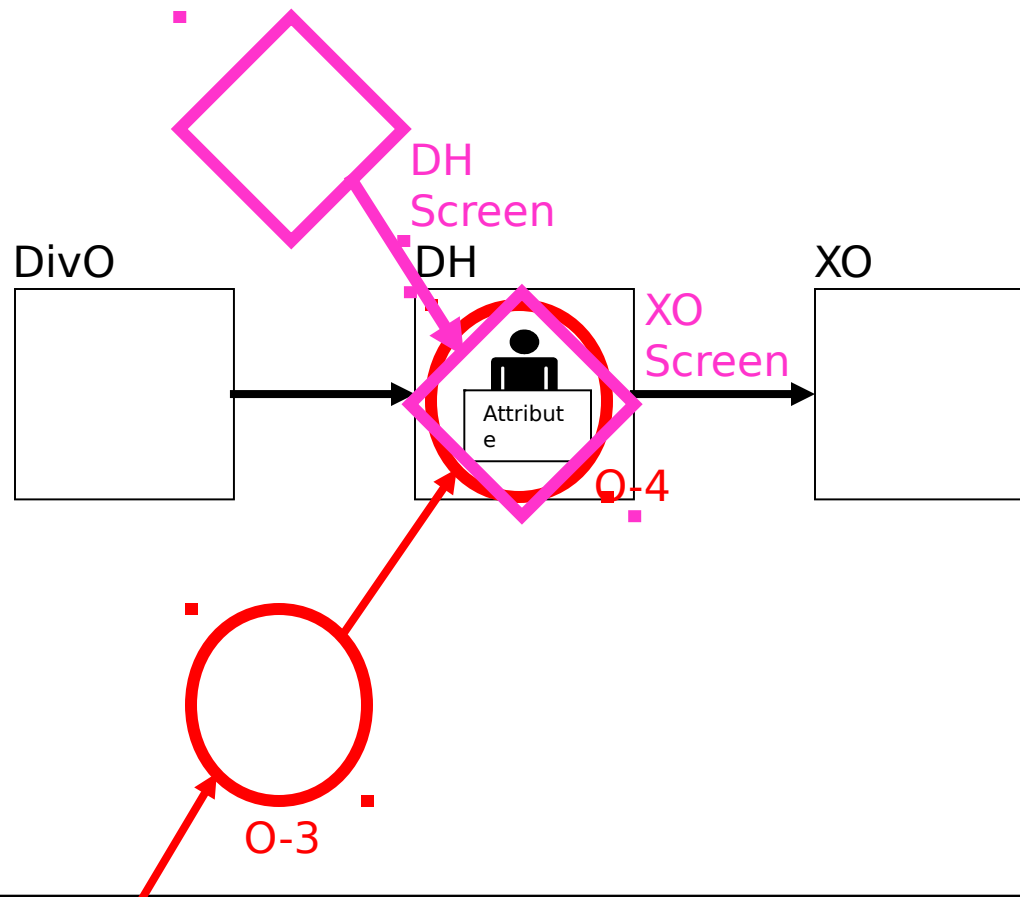
Promotion





Process Flow 3

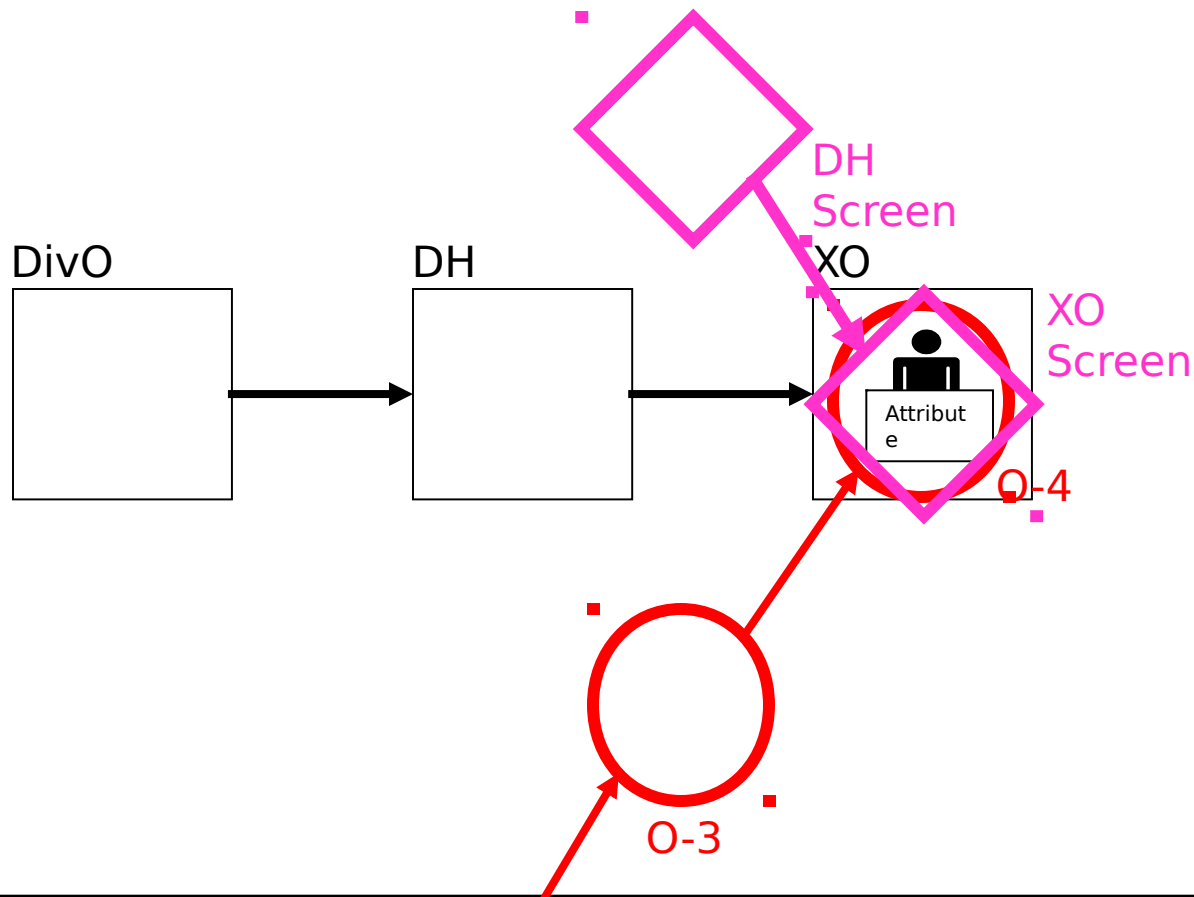
Selection



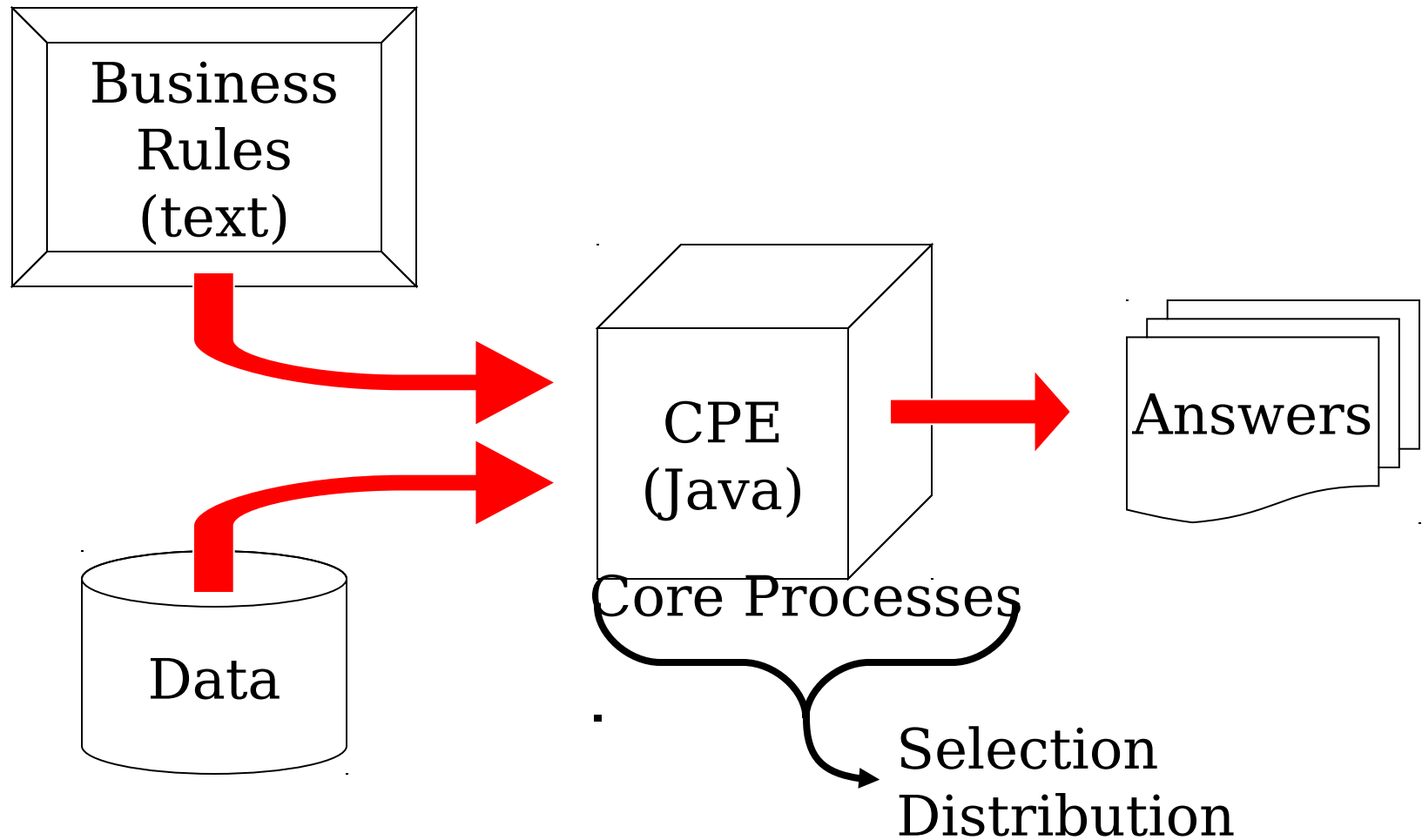


Process Flow 4

Rotation



Career Path Engine





Sample Rule

Event first runs in month 9, and repeats every 12 months

```
// 0-3 Promotion
BEGIN EVENT
9,12
Rank == 0-2,YearOfService == 3
CHANGERULES
0.9%
Rank = 0-3
END EVENT
```

Two predicates in this pool rule; eligible entities are O-2s in their third year of service

90% of O-2s will promote

Change their rank to O-2

Benefits



- “Intertwining” is easier
- Processes can share data
- Encapsulation of business rules; can add/remove/modify a “process chain” without fundamentally changing the others
- Scalability
 - Enlarge model boundaries
 - No attribute explosion
 - Develop more holistic understanding of domain
 - Parallelizable or distributable



Time Variations

- Model can change over time
- For example: DH tour length as an attribute
- Can stop and modify
- Can record and roll-back